

# Mine Modelling using GIS technology in Albania

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**Abstract:** *Albania is a country with rich mineral resources. Mineral exploration, exploitation and processing constitute a key component of the Albanian economy, due to a traditional mining industry that has been a solid foundation to the country economic sector generating substantial revenues. The minerals mined, and treated in the past, which still remain in Albania, include mainly chrome, copper, iron-nickel, coal, oil etc. One of the biggest challenges of the Albanian mining today is the need for modern planning and management. To reach this goal the best instrument to be used is modelling of mineral sources. Mine modelling has solved many technical problems in the exploration process, mine designing, and extraction of minerals. Mine modelling in Albania started very early and methods have progressed and advanced in time. During 1950-1990 main modelling methods have been mathematical and geometrical. New democratic changes on 1991 brought the opening of Albanian with world, what made possible cooperation with west countries and introducing of advanced technology in mine modelling. The high request for full mineral sources modelling obliged the use new of computer program, digitisation of documentation, 3D modelling, etc. This article presents a general overview of the mine development in Albania, mine modelling and brings same case on new GIS technologies applications used for this purpose.*

**Keywords:** Mine, Mine modelling, GIS, Albania

## 1. General information on mining industry in Albania

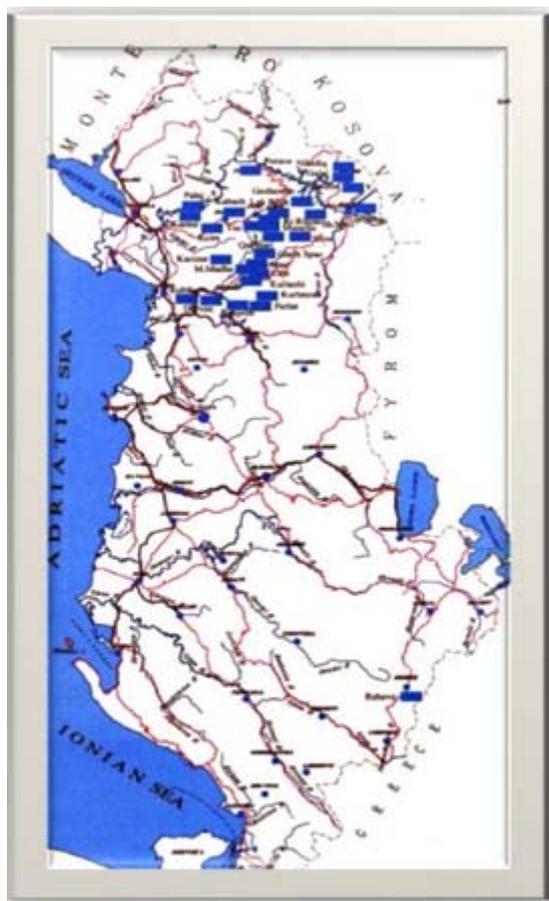
Albania is a country with rich mineral resources. Mineral exploration, exploitation and processing constitutes a key component of the Albanian economy, due to a traditional mining industry that has been a solid foundation to the country economic sector generating substantial revenues.

Mining industry development in Albania has passed through three main stages: *The first stage* includes the period before the Second World War. It has been marked by two important events of the mining industry: In 1922 was compiled the first Geological Map of Albania, the first of its kind in Balkan; and in 1929 signed the approved Mining Law of the Albanian Kingdom, which paved the way to the exploration and exploitation of mineral resources. *The second stage* (1944-1994) marks the period when the mining activity has been organized in state-owned enterprises. *The third stage* includes the period from 1994 up to date. It is the most important period of the mining industry, during which it was enabled the transition from a centralised economically to free market. With the assistance of the World Bank, in 1994 it was composed and approved the Mining Law of Albania.

The licensing process initiated in 1994, upon approval of the Albanian Mining Law. In 1995 was approved the Law "On Concessions". With its approval important area of the mining industry in, chrome, copper, iron-nickel and bitumen were given on concession. The concession was applied for the determined parts of the mining industry that required overall investments in prospecting, exploration, exploitation or restructuring of the processing industry. According of National Mineral resource Agency (AKBN), the licensing process, issuance of mining permits started early in 1995. Actually are given more than 700 mining licenses in Chromium, Copper (Fig.1), Iron-nickel, massive limestone, Lime-stone tiles; Siliceous sandstone Gypsum-anhydrites and Clays.

Through studies and geologic exploration carried out in the course of the last 50 years have been discovered a lot of important mineral resources. The mining potential in Albania is big and various. Minerals deposited in Albanian territory are: *chromites, iron-Nickel/ Nickel Silicate, Copper, Coal, Peats/turfs, Natural bitumen, Bituminous sands, Bituminous coal, Pirobitumens, Titanomagnetites, Bauxite, Barite, Mergel, Trepele, Polymetals, Feldspat, Fluroite, Sulfur, Phypopilitite, Talc, Chalk, Limestones, Dolomites, Carbonatic decorative stones, Basalts, Magnesites, Phosporites, Olivinites, Gypsum - anhydrites, Volcanic glass, Granites, Rock salts, Clays, Kaolin, Silica sands - quartzites, River bad gravels, Ofiolitic decorative stones.*

Actually the main priorities of Mining Industry development in Albania are: (1) Production increase of the traditional minerals, such as: chrome, copper, nickel, as well as enhancement of their processing scale, in order to make them competitive in supplying the domestic and foreign market; (2) Expansion of the production range and processing of other minerals, such as: bituminous sands, olivinites, basalts, decorative stones, etc.; (3) Promotion of existing reserves, enabling the exploitation, processing and marketing of the products, both for the domestic and foreign market; (4) Application of updated technologies in mines, documentation, modelling, processing units (enriching plants, breaking-fractioning-grinding plants, metallurgic factories, etc.) enabling a complex mineral exploitation; (5) Enhancement of mine management methods; (6) Effective utilization of the existing mineral resources and of those to be found in the future, in order to introduce them in the market increasing revenues from their exportation, as well as raw or processed products. (7) Approximation mining law according of EU Directives. (8) Training of staff relating new methods and technologies.



**Figure1:** Cooper mines Map in Albania

## 2. Mine modelling in Albania

Mine modelling in Albania started very early, and the modelling methods has been improved progressively in time. These methods have been very helpfully solving many technical problems during different phases of mining as geological exploration and discovering, mine designing and mineral exploitation. During 1950-1990 the main used mine's modelling methods have been those geometrical and mathematical. Based on these methods were designed the most rational ways of mineral reserves exploitation, mine and geological works volumes calculation, mine works direction, etc. Main used methods have been: (1) Vertical geological cutting; (2) Horizontal geological cutting; (3) Isoline method; (4) Method of graphical volume image; and (5) Static modelling methods with equal materials. The instruments used during this period have been: Aksenograph, Afinograph, and Pantograph.

## 3. Introducing new technology in mine modelling

Political changes on '90 brought opening of Albania to other countries. These changes made possible more cooperation possibilities with western countries bringing and introducing new advanced technologies in mine modelling. First program introduced was AutoCAD and later other programs. Actually in Albania are used largely ArcGIS, Micromine etc. Preparation of students with these programs is one of highest University priority studies. Mean time in all mines in

Albania started to use new mine modelling technologies. The high demands for mine modelling expanded the need of using more programs for mine modelling. Actually the programs used are: SURPAC to solve the problems on mine design and mineral exploitation, for open mine and underground mine based on the data got from the exploration and discovering phase; DATAMINE managing the geological data, development plans, mine designing, analyse, data elaboration, and data interpretation in 2D and 3D; ArcGIS and MICROMINE.

## 4. Problems and Challenges facing mine modelling in Albania

Like in every economical sector of Albania, mining industry faced with many problems and challenges where the most important are: (1) Mining reserves management; (2) Geological reserves estimation; (3) Mine preparation for full reserves exploitation; (4) Technological processing of extracted mineral; (5) Data base creation for mines management, mining works estimation, geological reserves estimation, comparison of calculated reserves with those extracted from exploitation process; (6) Mineral source modelling; (7) Mining law approximation with EU directives and international standards; (8) Foreign investment promotion; (9) Human resource development; (10) New technology introduction on exploration, discovering, exploitation, and mineral processing process; (11) Mine Closing and environment rehabilitation.

## 5. GIS application in mine modelling in Albania

There are many examples on new advanced mine modelling technologies used in Albania. In this paper we are bringing some of them used mainly on ore bodies modelling, mineral reserves calculation, and mines area inventory.

### 5.1. GIS application in Ore bodies modelling

From many examples of GIS used on ore bodies modelling, we are presenting following very shortly the case of Fe-Ni mine on Skroskë – Librazhd, Albania. This mine is discovered since 1956 from Czechoslovakian experts. The mine has an elongation about 2.5 km and declination 4 km in total surface 10 km<sup>2</sup>. The mineral excavation started on 1985. Parallel with other technologies recently in this mine started to be used the GIS technology mainly on: geological reserves estimation; geological drilling processing; 2D and 3D modelling; mining works optimisation; and Geodatabase creation. The main program used in this mine is MICROMINE supported by other programs as AutoCAD Map 3D 2011, Raster Design and Microsoft Excel. Using of GIS passed through these steps: (1) Digitalisation of 21 cross sections, drilling maps, ventilation system map, and machines placed map. (2) Geodatabase creation for existing drilling; (3) 3D mine modelling building using MICROMINE. Referred to *Shehu A<sup>1</sup>* results achieved from GIS application in this mine are: (1) Database creation including: Drilling database, mineral quality data base, database of geological profiles, database of main mining works; (2) 3D mine model creation.

Figure 2 presents the 3D model of this mine including ore bodies and mining works.

## 5.2. GIS application on Geological reserves estimation



**Figure 2:** 3D model of Skroska mine  
[Source: Shehu A, 2014]

Another example of GIS application in Albania is the case of Geological reserves estimation. From many cases we are bringing here briefly the case of Copper mineral source on Tuç, Repts, Albania. The mining works on this mineral source started in 1978. The goal of GIS using in this mine was PRE-ESTIMATION of reserves and planning of preparation and mineral extraction. The programs used on ore bodies modelling in this mine are: AutoCAD, GIS, GeoSoft and MICROMINE. Referred to *Pekmezi J<sup>ii</sup>*, results of GIS used in this mine are: (1) Estimation of geological reserves of this mineral source; (2) Database creation; (3) Drilling map and geological profiles creation; (4) Ore bodies modelling creation and reserves calculation. The database realised using Micromine program supported by Excel. The mine model is realised using data of 255 drilling. From the other side the ore bodies' model is prepared using 18 horizontal cutting. Linking the ore bodies is prepared using [wireframe]. The surfaces (area) are built using method of equal triangles. Calculation of volumes and quantity of reserves of ore bodies is realised estimating the built volume from [wireframe] including the [assay] format. Lastly the calculation of quality of ore bodies is done by using the [weighted average]. **Figure 3** presents the 3D model of this mineral source using GIS.

## 5.3. Mines inventory in Albania

The newest project where GIS is applying is the mines inventory in Albania. This project is developed by students of Faculty of Geology and Mine in cooperation with National Agency of Natural resource. This project is under developing taking into consideration the international experience especially the Australian one. Creating the GIS map and mines inventory is done through different themes as: Mineral deposits and shows; Operating mines; History of mines; Minerals; Industry; Transport and infrastructure; Geography; Topography, etc. Each main theme is detailed on subtheme. The project is still under development and has as base program ArcGIS.

## 6. Conclusions and Recommendations

Based on our observations and considering the above information we arrive in the following conclusions and recommendations:

### 6.1 Conclusions

1) For a long time, in Albania the preparation of geological and mining documentation, exploration and discovering, reserves estimation, management, planning, mining works direction, etc, have been realised with traditional methods.

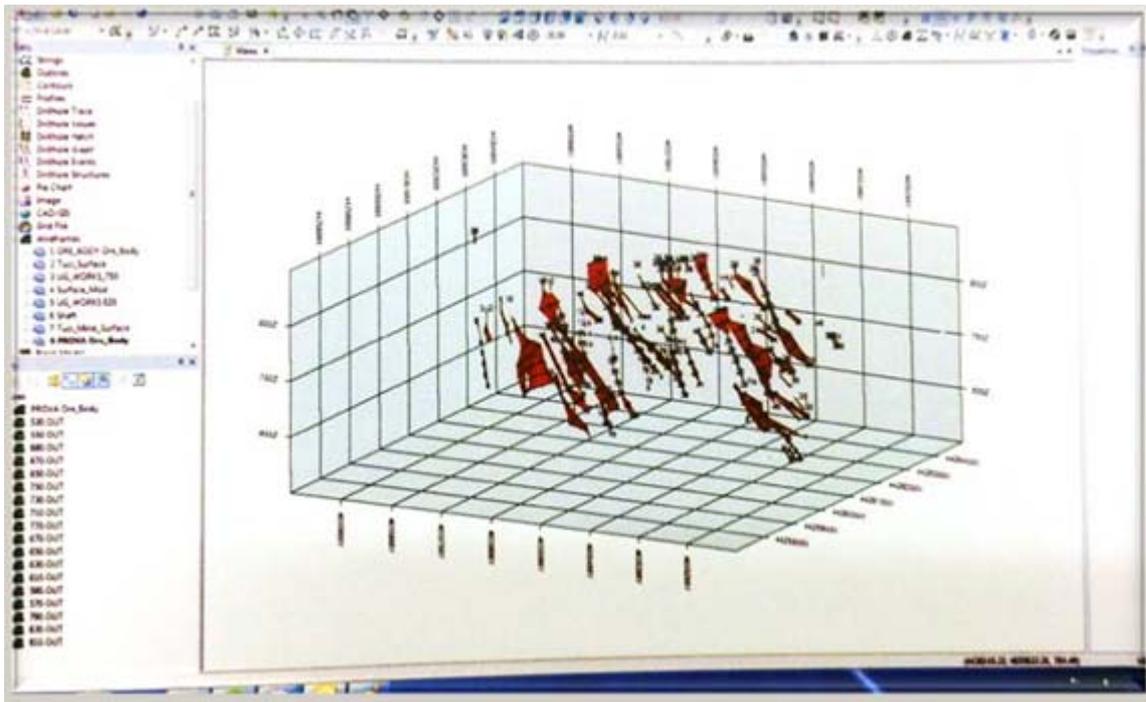


Figure 3: 3D model of ore bodies of Tuç mineral source [Source: Pekmezi J, 2014]

- 2) Recently for preparing the mining and geological documentation used successfully the most advanced technology and programs like: AutoCAD, ArcGIS, Micro mine, Surpac, etc.
- 6) Application of new and advanced technology is necessary to be followed with human resource development, through staff training and curriculum development in schools especially in new technology use.

- 3) Because of seniority documents and inaccuracy of initial data taken from traditional documentation, the use of new technology is associated with inaccuracy on ore bodies and mine works modelling.

## 6.2 Recommendations

- 1) Full management of the mineral sources can not be any more with traditional methods. It is highly recommended to include in all mines in Albania application of new advanced technologies on documentation preparation and mine modelling.
- 2) To eliminate the inaccuracy caused by old documentation is necessary to digitise all existing documents and based on the field survey to make the necessary correction.
- 3) In the case of geological reserves re-estimation of one existing mineral resource, where mining works have been done, is necessary to control the geomatic net used, and to correct the discrepancies on coordinates taken from the measures during the exploration and discovering works phase, compared with the measurement realised in the phase of opening and mine preparation for exploitation.
- 4) The practice shown that building of horizontal cutting of ore bodies must be realised according of preliminary project of the mineral source opening.
- 5) It is necessary to review the existing law concerning the mine documentation and rules for advanced technology application according of European Community Directives.

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## Author Profiles



Edmond **HOXHA**, received the PhD degree on Geosciences and Environ-ment on Polytechnic University of Tirana, Faculty of Geology and Mine. He studied also leadership on Harvard University. He has huge experience working with Govern-ment of Albania and International institutions like World Bank, European Union, GIZ, etc. He was Deputy Minister of European Integration of Albania. He is Founder of "Albanian Center of Excellence" and publisher of Scientific Journal "Albanian Excellence". He is member of Eurosciences; International Association of Sciences, Techno-logy and Development. He speaks English and German language. Actually he is a professor in Faculty of Geology and Mine, Tirana – Albania, teaching GIS technology and Mine Modeling.



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<sup>i</sup> **Shehu A** “*Zhvillimi dhe përdorimi i Sistemit të Informacionit Gjeografik GIS në miniera. Aplikimi në minierën e Fe/Ni Skroskë*” MicroTezë 2014

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